1904MNRAS..64..813S

U. S. C. & G. SURVEY
LIBRARY AND ARCHIVE
NOV 22 1904
ACC. NO.

MONTHLY NOTICES

OF THE

ROYAL ASTRONOMICAL SOCIETY.

VOL. LXIV. SUPPLEMENTARY NUMBER, 1904. NO. 9

On the Eclipses of the Satellites of Saturn in the Years 1904 *and* 1905. By H. Struve.

The cycle of eclipses and other phenomena of the satellites of *Saturn*, which begins in the present year and will extend over the next five years, gives an opportunity for a series of important observations to which the attention of astronomers may be directed. In the first place, the dimensions of the planet can be determined by these observations with considerable precision. At the same time they will lead to interesting conclusions as to the diameters of the satellites and the atmosphere of the planet and the penumbra. Further they will serve to correct the elements of the orbits of the satellites.

In previous periods very few observations of these phenomena have been made. During the last period, beginning with the year 1889, more attention has been directed to them, thanks to the predictions of Mr. Marth. Some observations of eclipses of the brighter satellites which have been published and discussed in the *Monthly Notices*, vol. liv., show the great accuracy of these observations, and the desirability of a more extensive repetition at the next opportunity. For the success of these observations it is important that astronomers should be acquainted with the conditions of the phenomena, particularly the times of the eclipses and the geocentric places of the satellites. During the next years the reappearances taking place after the opposition can be observed with more facility and accuracy than the disappearances before the opposition, as they occur at greater distances from the planet's limb. On the contrary, after 1907, when the Earth

1904MNRAS..64..813S

will have passed through the plane of the ring, the disappearances before the opposition are easier to observe.

The following note refers to the eclipses in the next two years. During the opposition of 1904 only the two interior satellites *Mimas* and *Enceladus* will be eclipsed. Whether we might succeed in the observations of eclipses of *Mimas* is very doubtful on account of the faintness of the satellite and the proximity of *Saturn's* disc. But in the case of *Enceladus* it is possible that the eclipses might be observed in *powerful* telescopes. The eclipses of *Enceladus* will begin about three or four months after the opposition, not before November, on the northern side of the planet's disc, and are distinguished by the fact that both the disappearances and reappearances are visible from the Earth. The beginning of the cycle of eclipses changes considerably according to the supposition to be made as to the dimensions of the planet. Assuming the polar semiaxis of the planet at mean distance to be $b_0 = 8''{\cdot}025$, the first eclipse of *Enceladus* will take place on November 19; assuming $b_0 = 7''{\cdot}825$, we find for the first eclipse December 18. The first value corresponds approximately to the dimension of the planet derived by measures with filar micrometers, the smaller value agrees with the result derived from the eclipses of *Rhea*, *Dione*, and *Tethys* in the years 1890–91 (*Monthly Notices*, vol. liv.), and approaches in the same time the mean value of the heliometric measures. Therefore the observation of the superior conjunctions of *Enceladus* in November and December of this year will lead to a more exact determination or at least to a maximum value of the polar diameter. In the following table are given the times of the heliocentric conjunctions, and for every tenth day the geocentric coordinates of *Enceladus*, x, y, referred to the axes of the ring; further, the semi-diameter of the disc b and the semi-duration of the eclipses, on the supposition $b_0 = 8''{\cdot}025$:

Superior Conjunctions of Enceladus, 1904.

Date.	Helioc. Conj. G.M.T.	Geoc. Coord. x	Geoc. Coord. y	Semi-diam. b	Semi-duration.
1904.	h m	″	″	″	h m
Nov. 10	0 11	+3·1	+9·2	7·8	...
11	9 4				
12	17 58				
14	2 52				
15	11 45				
16	20 39				
18	5 32				
19	14 26	+3·0	+8·9	7·7	0 2
20	23 19				
22	8 13				

1904MNRAS..64..813S

Date.	Helioc. Conj. G.M.T.	Geoc. Coord.		Semi-diam. b	Semi-duration.
1904.	h m	x "	y "	"	h m
Nov. 23	17 6				
25	2 0				
26	10 53				
27	19 47				
29	4 40	+2·8	+8·7	7·6	0 11
30	13 34				
Dec. 1	22 27				
3	7 21				
4	16 14				
6	1 8				
7	10 1				
8	18 55				
10	3 48	+2·5	+8·4	7·5	0 16
11	12 42				
12	21 35				
14	6 29				
15	15 22				
17	0 16				
18	9 9				
19	18 3	+2·2	+8·1	7·4	0 19
21	2 56				
22	11 50				
23	20 43				
25	5 37				
26	14 30				
27	23 24				
29	8 17	+1·9	+7·8	7·3	0 22
30	17 10				

As can be seen the distance of the satellite from the limb at the heliocentric conjunction on November 10 is nearly 2″, on December 19 still nearly 1″, distances in which with powerful instruments and in the most favourable conditions it will be possible to recognise *Enceladus*.

In the next year, 1905, attention may be drawn to the two eclipses of *Japetus*, the first on May 15, when *Japetus* will pass also through the shadow of the ring-system; the second, August 3, on which *Japetus* is only eclipsed by the planet. In both instances the satellite will be seen from the Earth at considerable distance from the disc of the planet and the rings. The following predictions are based on the elements of *Japetus*

1904MNRAS..64..813S

deduced formerly by myself and, as to the dimensions in the mean distance, on the suppositions :

	″
Semi-axis of the outer ring	19·79
Semi-axis of Cassini's division	17·24
Semi-axis of the inner ring	12·89
Major semi-axis of the planet	8·735
Minor " " "	7·825

The uncertainty of these values may produce changes of ten minutes and more in the predicted times. The computed geocentric coordinates x, y are referred to the axes of the ring.

1. *Eclipse of Japetus* 1905 *May* 15.

	G.M.T.	Geoc. Coord.	
	h m	x ″	y ″
Ingress into the shadow of the outer ring ...	3 34	−55·2	−25·7
Helioc. transit through Cassini's division ...	4 49	−53·1	−25·3
Ingress into the shadow of the planet	5 57	−51·3	−25·0
Egress out of the shadow of the planet	15 55	−35·0	−22·5
Ingress into the shadow of the inner ring ...	18 11	−31·3	−21·9
Helioc. transit through Cassini's division ...	20 23	−27·7	−21·4
Egress out of the shadow of the outer ring ...	21 39	−25·6	−21·0

In the first part of the phenomenon the heliocentric passage of *Japetus* through the interval between the planet and the interior ring remains invisible, as the satellite enters the shadow of the planet before coming out of the shadow of the interior ring. In the second part of the phenomenon, however, a nearly central passage through the interval and the crape-ring takes place, like the transit, predicted by Marth on 1889 November 1–2, which formed one of the most interesting observations of Barnard (*Monthly Notices*, vol. l.). Particular attention might be given to the appearance of the satellite during the transit through Cassini's division. Confusion with the other satellites is out of question, for all the other satellites are much nearer the line of the ring. As the planet on May 15 has 12° southern declination, and passes the meridian at 6¾ o'clock in the morning, this eclipse will be observed more favourably in southern observatories, while in northern observatories the low position of the planet and early twilight will render the observation difficult.

2. *Eclipse of Japetus* 1905 *August* 3.

	G.M.T.	Geoc. Coord.	
	h m	x ″	y ″
Ingress into the shadow of the planet (disapp.) ...	5 18	−19·6	−15·8
Egress out of the " " " (reapp.) ...	8 46	−13·1	−14·8

1904MNRAS..64..813S

The beginning of this eclipse can only be observed in countries east of Greenwich. For orientation it may be remarked that *Enceladus*, *Tethys*, *Dione*, and *Rhea* will be on the eastern side of the planet near the axis of the ring, and *Titan* not far from the western elongation.

Concerning the other satellites only *Tethys* will be eclipsed in the year 1905, besides *Mimas* and *Enceladus*. The reappearances of *Tethys* after the opposition, taking place at a greater distance from the planet's limb, may be well observed. The opposition of 1906 is still more favourable for these observations, as the eclipses of all the interior satellites, *Tethys*, *Dione*, and *Rhea*, still occur at sufficient distances from the ring. In the year 1907 the interior satellites move very near the axis of the ring; in the same year the cycle of eclipses of *Titan* begins. In these years also the transits of the satellites and their shadows before the planet's disc, and the occultations and the conjunctions with the ends of the ansæ, will be worthy of particular attention.

The following tables give the times of the eclipses for the opposition of 1905 and also, for intervals of about fifteen days, the geocentric distance s of the satellite from the limb and the geocentric position-angle p, counted from the north pole of the planet (to the west for disappearance, to the east for reappearance). In computing the tables the latest elements of *Mimas* and *Tethys* (*Astron. Nachr.* vol. clxii.) are used, and the semi-axes $a_0 = 8''{\cdot}735$, $b_0 = 7''{\cdot}825$. The possible error in the predicted times should not exceed a few minutes. In the approximate indications of the eclipses published in the *Berliner Jahrbuch* for 1905 the improved elements could not be considered. *Before* the opposition only the disappearances, *after* the opposition only the reappearances are visible from the Earth.

Eclipses of Mimas, 1905.

Disappearance.

Date. 1905.		G.M.T. h	m	s. $''$	p. West. $^\circ$
May	25	4	24	1·0	64
	26	3	1		
	27	1	38		
	28	0	15		
	28	22	53		
	29	21	30		
	30	20	7		
	31	18	44		
June	1	17	21		
	2	15	58		
	3	14	35		
June	4	13	12		
	5	11	49		
	6	10	26		
	7	9	3		
	8	7	41		
	9	6	18	1·0	63
	10	4	55		
	11	3	32		
	12	2	9		
	13	0	46		
	13	23	23		

1904MNRAS..64..813S

Date. 1905.		G.M.T. h	m	*s.* ′	*p.* West. °	Date. 1905.		G.M.T. h	m	*s.* ″	*p.* West. °
June	14	22	0			July	20	17	30		
	15	20	37				21	16	8		
	16	19	14				22	14	45		
	17	17	51				23	13	22		
	18	16	28				24	11	59		
	19	15	5				25	10	36	0·6	58
	20	13	43				26	9	13		
	21	12	20				27	7	50		
	22	10	57				28	6	28		
	23	9	34				29	5	5		
	24	8	11	0·9	62		30	3	42		
	25	6	48				31	2	19		
	26	5	25			Aug.	1	0	56		
	27	4	2				1	23	33		
	28	2	40				2	22	10		
	29	1	17				3	20	48		
	29	23	54				4	19	25		
	30	22	31				5	18	2		
July	1	21	8				6	16	39		
	2	19	45				7	15	16		
	3	18	22				8	13	53	0·4	56
	4	16	59				9	12	31		
	5	15	36				10	11	8		
	6	14	13				11	9	45		
	7	12	51				12	8	22		
	8	11	28				13	6	59		
	9	10	5				14	5	36		
	10	8	42	0·8	60		15	4	13		
	11	7	19				16	2	51		
	12	5	56				17	1	28		
	13	4	33				18	0	5		
	14	3	11				18	22	42		
	15	1	48				19	21	19		
	16	0	25				20	19	56		
	16	23	2				21	18	34		
	17	21	39				22	17	11		
	18	20	16				23	15	48	0·1	53
	19	18	53								

1904MNRAS..64..813S

Eclipses of Mimas, 1905.

Reappearance.

Date. 1905.		G.M.T. h m	*s.* "	*p.* East. °	Date. 1905.		G.M.T. h m	*s.* "	*p.* East. °
Aug.	23	17 39	0·0	57	Sept.	26	16 6		
	24	16 16				27	14 44		
	25	14 54				28	13 21		
	26	13 31				29	11 59		
	27	12 8				30	10 36		
	28	10 46			Oct.	1	9 14		
	29	9 23				2	7 51		
	30	8 0				3	6 28		
	31	6 38				4	5 6		
Sept.	1	5 16				5	3 43		
	2	3 53				6	2 21		
	3	2 30				7	0 58		
	4	1 8				7	23 36		
	4	23 45				8	22 13	1·9	64
	5	22 23				9	20 51		
	6	21 0				10	19 28		
	7	19 38	0·8	60		11	18 5		
	8	18 15				12	16 43		
	9	16 53				13	15 20		
	10	15 30				14	13 58		
	11	14 7				15	12 35		
	12	12 45				16	11 13		
	13	11 22				17	9 50		
	14	10 0				18	8 27		
	15	8 37				19	7 5		
	16	7 15				20	5 42		
	17	5 52				21	4 20		
	18	4 29				22	2 57		
	19	3 7				23	1 35		
	20	1 44				24	0 12	2·3	66
	21	0 22				24	22 49		
	21	22 59				25	21 27		
	22	21 37	1·4	62		26	20 4		
	23	20 14				27	18 42		
	24	18 52				28	17 19		
	25	17 29				29	15 56		

1904MNRAS..64..813S

Date. 1905.	G.M.T. h m	s. ″	p. East. °	Date. 1905.	G.M.T. h m	s. ″	p. East. °
Oct. 30	14 34			Nov. 11	20 40		
31	13 11			12	19 17		
Nov. 1	11 49			13	17 55		
2	10 26			14	16 32		
3	9 3			15	15 9		
4	7 41			16	13 47		
5	6 18			17	12 24		
6	4 56			18	11 2		
7	3 33	2·5	67	19	9 39		
8	2 10			20	8 17		
9	0 48			21	6 54		
9	23 25			22	5 31	2·4	68
10	22 2						

Eclipses of Enceladus, 1905.

Disappearance.

Date. 1905.	G.M.T. h m	s. ″	p. West. °	Date. 1905.	G.M.T. h m	s. ″	p. West. °
May 24	22 33	0·8	58	June 22	17 6	0·9	58
26	7 26			24	1 59		
27	16 19			25	10 52		
29	1 12			26	19 45		
30	10 5			28	4 38		
31	18 58			29	13 31		
June 2	3 51			30	22 24		
3	12 44			July 2	7 17		
4	21 37			3	16 10		
6	6 30			5	1 3		
7	15 23			6	9 56		
9	0 16	0·9	58	7	18 49		
10	9 9			9	3 42	0·7	56
11	18 2			10	12 35		
13	2 55			11	21 28		
14	11 48			13	6 21		
15	20 41			14	15 14		
17	5 34			16	0 7		
18	14 27			17	9 0		
19	23 20			18	17 53		
21	8 13			20	2 46		

1904MNRAS..64..813S

Date. 1905.		G.M.T. h	m	s. ″	p. West. °	Date. 1905.		G.M.T. h	m	s. ″	p. West. °
July	21	11	39			Aug.	8	7	9	0·3	49
	22	20	32	0·5	53		9	16	2		
	24	5	25				11	0	55		
	25	14	18				12	9	49		
	26	23	11				13	18	42		
	28	8	4				15	3	35		
	29	16	57				16	12	28		
	31	1	51				17	21	21		
Aug.	1	10	44				19	6	14		
	2	19	37				20	15	7		
	4	4	30				22	0	1		
	5	13	23				23	8	54	0·1	44
	6	22	16								

Reappearance.

Date. 1905.		G.M.T. h	m	s. ″	p. East. °	Date. 1905.		G.M.T. h	m	s. ″	p. East. °
Aug.	23	10	40	0·1	44	Sept.	22	14	17	1·8	50
	24	19	34				23	23	11		
	26	4	27				25	8	4		
	27	13	21				26	16	58		
	28	22	14				28	1	52		
	30	7	8				29	10	45		
	31	16	1				30	19	39		
Sept.	2	0	55			Oct.	2	4	32		
	3	9	48				3	13	26		
	4	18	42				4	22	19		
	6	3	35				6	7	13		
	7	12	29	1·0	47		7	16	6		
	8	21	22				9	1	0	2·5	52
	10	6	16				10	9	53		
	11	15	9				11	18	47		
	13	0	2				13	3	41		
	14	8	56				14	12	34		
	15	17	49				15	21	28		
	17	2	43				17	6	21		
	18	11	36				18	15	15		
	19	20	30				20	0	8		
	21	5	23				21	9	2		

1904MNRAS..64..813S

Date. 1905.		G.M.T. h	m	s. ″	p. East. °
Oct.	22	17	56		
	24	2	49	3·0	54
	25	11	43		
	26	20	36		
	28	5	30		
	29	14	24		
	30	23	17		
Nov.	1	8	11		
	2	17	5		
	4	1	58		
	5	10	52		
	6	19	45		
	8	4	39		
Nov.	9	13	32	3·2	55
	10	22	26		
	12	7	20		
	13	16	13		
	15	1	7		
	16	10	1		
	17	18	54		
	19	3	48		
	20	12	41		
	21	21	35		
	23	6	29		
	24	15	23	3·2	56

Eclipses of Tethys, 1905.

Disappearance.

Date. 1905.		G.M.T. h	m	s. ″	p. West. °
May	24	18	36	0·1	48
	26	15	54		
	28	13	12		
	30	10	30		
June	1	7	48		
	3	5	6		
	5	2	24		
	6	23	42		
	8	21	0	0·2	50
	10	18	19		
	12	15	37		
	14	12	55		
	16	10	13		
	18	7	31		
	20	4	49		
	22	2	7		
	23	23	25	0·3	49
	25	20	43		
	27	18	1		
	29	15	20		
July	1	12	38		
July	3	9	56		
	5	7	14		
	7	4	32		
	9	1	51	0·3	47
	10	23	9		
	12	20	27		
	14	17	46		
	16	15	4		
	18	12	22		
	20	9	41		
	22	6	59		
	24	4	17	0·3	43
	26	1	36		
	27	22	54		
	29	20	12		
	31	17	31		
Aug.	2	14	49		
	4	12	8		
	6	9	26		
	8	6	45		
	10	4	3	0·2	37

1904MNRAS..64..813S

Date. 1905.		G.M.T.		s.	p. West.	Date. 1905.		G.M.T.		s.	p. West.
		h	m	″	°			h	m	″	°
Aug.	12	1	22			Aug.	19	14	36		
	13	22	40				21	11	54		
	15	19	59				23	9	13	0·1	31
	17	17	17								

Reappearance.

Date. 1905.		G.M.T.		s.	p. East.	Date. 1905.		G.M.T.		s.	p. East.
		h	m	″	°			h	m	″	°
Aug.	23	10	35	0·1	28	Oct.	11	12	55	2·9	42
	25	7	54				13	10	14		
	27	5	13				15	7	33		
	29	2	32				17	4	53		
	30	23	52				19	2	12		
Sept.	1	21	11				20	23	31		
	3	18	30				22	20	51		
	5	15	49				24	18	10	3·4	45
	7	13	8	1·2	34		26	15	29		
	9	10	27				28	12	49		
	11	7	47				30	10	8		
	13	5	6			Nov.	1	7	27		
	15	2	25				3	4	47		
	16	23	44				5	2	6		
	18	21	4				6	23	25		
	20	18	23				8	20	45	3·7	46
	22	15	42	2·1	39		10	18	4		
	24	13	1				12	15	23		
	26	10	21				14	12	43		
	28	7	40				16	10	2		
	30	4	59				18	7	21		
Oct.	2	2	18				20	4	41		
	3	23	38				22	2	0	3·6	47
	5	20	57				23	23	19		
	7	18	16				25	20	39		
	9	15	36	2·9	42						

Königsberg : 1904 *August* 20.

1904MNRAS..64..813S

On the Determination of Longitude on the Planet Jupiter.

By G. W. Hough.

I have read with some astonishment the paper by Mr. A. S. Williams in the *Monthly Notices* for March 1904 on the determination of longitude on the planet *Jupiter*. It is difficult to believe that he was in earnest in his presentation of the subject. As an illustration of the kind of logic employed, in paragraph 15 he asserts that in a micrometer measure of the central meridian there are four sources of error, in the observation of a transit only one source of error; hence the latter is the more accurate method. In other words, one can guess the centre of the disc better than one can measure it.

The table of so-called data consists almost entirely of the comparison of five or six observations *inter se*, selecting such as show a small mean residual. About one-third of the data cited has a mean residual of $+1^{m}\cdot0$ or less, a purely imaginary value. One minute of rotation time means $0''\cdot17$ of arc. The table of data is open to just criticism, but I shall simply call attention to a few grave errors.

Schmidt, Red Spot 1879–87, carried a mean error $\pm3^{m}\cdot0$, corrected observations $\pm1^{m}\cdot9$, *not* $\pm1^{m}\cdot5$. Barnard, Red Spot 1880–2, carried a mean error $\pm4^{m}$, *not* $\pm0^{m}\cdot7$. Barnard, Red Spot 1891, the residual $\pm0^{m}\cdot8$ was derived from a comparison with Marth's Ephemeris, which did not represent the motion; the true mean residual is $\pm1^{m}\cdot8$. Williams, Red Spot 1899, carries a mean residual $\pm2^{m}\cdot3$, *not* $\pm3^{m}\cdot1$. Williams, Red Spot 1900, carries a mean residual $\pm2^{m}\cdot8$, *not* $\pm0^{m}\cdot8$. Jedrzejewicz, Red Spot 1880–1; these observations were made with the help of a micrometer, and according to the observer's own statement should carry a mean residual $\pm2^{m}\cdot2$. The residual $\pm0^{m}\cdot5$ is fictitious. Spots giving the short rotation period are not used at all.

From such a "discussion" he gets the following:

Mean error: Micrometer, $\pm2^{m}\cdot0$.
„ Eye estimates, $\pm1^{m}\cdot7$.

Hence the following logical conclusions:

1. A single eye estimate is decidedly superior in point of accuracy to micrometer measures.

2. One can bisect the disc of the planet by a single estimation with an average error of $0''\cdot27$ of arc, and under favourable conditions to $0''\cdot10$ arc. It is unnecessary to make any extended comments on such data and the inferences that may be drawn from them, but rather to add something to our knowledge of the magnitude of error in micrometer and eye-estimate work. Hitherto we have had speculation and conjecture rather than investigation regarding the limit of error in eye estimates.